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Title: Understanding the relationship between coach and athlete perceptions of training intensity in youth sport

Running title: The relationship between coach and athlete perceptions of intensity

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Abstract

To alleviate issues arising from the over/under prescription of training load, coaches must ensure that desired athlete responses to training are being achieved. The present study aimed to assess the level of agreement between the coach intended (pre-session) and observed (post-session) rating of perceived exertion (RPE), with athlete RPE during different training intensities (easy, moderate, hard). Coach intended RPE was taken prior to all field based training sessions over an 8 week in-season period. Following training, all coaches and athletes, whom were participants in hockey, netball, rugby and soccer were asked to provide an RPE measure for the completed session. Sessions were then classified based on the coaches intended RPE, with a total of 28, 125 and 66 easy, moderate and hard training sessions collected respectively. A univariate analysis of variance was used to calculate within-participant correlations between coach intended/observed RPE and athlete RPE. *Moderate* correlations were found between coach intended and athlete RPE for sessions intended to be moderate and hard whilst a *small* correlation was found for sessions intended to be easy. The level of agreement between coach and athlete RPE improved following training with coaches altering their RPE to align with those of the athlete. Despite this, *moderate* and *small* differences between coach observed and athlete RPE persisted for sessions intended to be easy and moderate respectively. Coaches should therefore incorporate strategies to monitor training load to increase the accuracy of training periodisation and reduce potential over/under prescription of training.

Keywords: Periodisation, Training Load, Soccer, Rugby, Hockey,

INTRODUCTION

The periodisation of training for youth athletes is a complex process, as the coach must foster the development of the athlete across years rather than on a week to week basis, commonly seen within senior sport (5). Regardless of whether the focus of training is on developing talent or athleticism, the long-term development of the youth athlete requires the coach to integrate a broad range of activities whilst also balancing exposure to competitive events and training (22). The manipulation of training volume and intensity must be systematic, stimulating continued physical adaptions through progressive overload whilst guarding against maladaptive training outcomes such as non-functional overreaching and overuse injury through the integration of sufficient recovery (9). Although a key factor in the successful long-term development of a youth athlete requires practitioners to utilise relevant training load monitoring tools (21), it is an undeniably challenging task.

Youth athletes frequently participate in multiple sports or across multiple age groups and playing standards within the same sport (25), meaning periodisation must be inclusive of the entirety of the youth athletes training schedule. Subsequently, all the youth athletes' coaches should work synergistically to construct a training program providing a sufficient stimulus to facilitate positive physiological adaption and prevent deconditioning whilst also avoiding an excessive ratio of workload-to-recovery (23). As 20% of school and club level athletes in the United Kingdom have suffered from non-functional overreaching and overuse injuries at some point in their careers (23), the combination of training load and recovery does not appear to be co-ordinated.

To optimise periodisation and maintain the workload-recovery ratio, coaches must ensure training sessions delivered achieve the desired internal response (6). Tracking an athletes rating of perceived exertion (RPE) provides the coach with a simple, quick and valid (16,19,20) method of quantifying the athletes' acute response to training. However, despite the precise nature of RPE, there is a lack of agreement between the intended session RPE set by the coach, the RPE observed by the coach and the athletes' RPE (5,6,27).

Research within swimming (27) and running (11) has found coaches to underestimate RPE for low intensity sessions but overestimate for high intensity sessions despite the association improving with athlete age and experience (2). Additionally, Murphy et al., found tennis coaches underestimated perceived intensity (24). The lack of agreement between coach intended/observed RPE and the athletes' perceptions of session intensity is exacerbated further in team sports where individual characteristics such as fitness and experience can influence RPE (14). Coaches must be cognizant of the perceptions of individual players within the team rather than assuming a global perception of intensity for the entire team. Research investigating the relationship between athlete and coach perceptions of session intensity within team sports is limited to elite standard youth soccer players (5,6). This research showed intended coach RPE underestimates athlete RPE for easier sessions and overestimates the athletes RPE for harder (5) sessions whilst the coaches observed session intensity underestimates athlete RPE on an individual level (6). Without a precise comprehension of the perceived training intensity on an individual level, athletes are at a risk of a maladaptive training response.

There is a reduced margin for error in youth sport where school and social stress can accumulate alongside fatigue derived from training load to increase the susceptibility of non-functional overreaching and overuse injury (23). Therefore, coaches must be confident that they are accurately prescribing and evaluating session intensity to avoid inappropriate training loads through the over/under prescription through a training session. As previously mentioned, periodisation requires planned fluctuations of training volume and intensity to promote overload and eventual super-compensation (4). Therefore, the school or club coach will vary session intensity based on the periodized schedule. Although previous literature (5) has investigated the influence of session intensity on the harmony between coach and athlete RPE, the coaches' perception of intensity was obtained prior to the session as an intended RPE. Recent research (6) has shown soccer coaches to change their perception of intensity post session, rather than maintain perceptions based on their originally intended RPE. Therefore, the aim of the present study was to assess the level of agreement between coaches intended RPE, coaches observed RPE and athletes RPE in youth rugby, soccer and hockey following training sessions the athletes perceived to be easy, moderate or hard.

METHOD

EXPERIMENTAL APPROACH TO THE PROBLEM

The study used an observational and longitudinal research design, whereby data were collected over an 8 week in-season training period from April to May 2016. Coaches were instructed to carry out their training sessions as normal with no interference from the researcher. All participants typically completed 2 training sessions per week

95 structured around a competitive fixture. Players and coaches were familiar with the RPE
96 collection method as it was regularly used within the school program prior to the
97 commencement of the study. Only data obtained from field based training sessions were
98 analysed.
99
100 **SUBJECTS**
101 Thirty-seven adolescent athletes including 9 female hockey (age 17.4 ± 0.8 years, height
102 164.7 ± 6.4 cm, body mass 60.0 ± 6.3 kg), 8 female netball (age 17.6 ± 0.6 years, height
103 167.8 ± 4.2 cm, body mass 58.0 ± 7.2 kg), 10 male rugby union (age 17.2 ± 0.4 years,
104 height 179.9 ± 5.4 cm, body mass 83.6 ± 11.5 kg) and 10 male soccer (age 17.2 ± 0.8
105 years, height 174 ± 0.05 cm, body mass 73.6 ± 7.1 kg) players were recruited from an
106 independent school in the United Kingdom. Four coaches (one per sport) were recruited
107 to take part. All coaches had >5 years coaching experience with 3 of the coaches
108 (rugby, hockey, netball) having coached at senior international level and 1 coach
109 (soccer) at elite youth level. All coaches had worked with the study participants for >1
110 year. Coaches, players and parents provided informed written consent prior to
111 participation. Ethics approval was granted by the Leeds Beckett University's ethics
112 committee.
113
114 **PROCEDURES**
115 Prior to all field-based training sessions, coaches were asked to rate the intended
116 intensity of the training session, providing a RPE measure to the lead researcher. The
117 RPE selection was made non-verbally, by pointing to the desired text descriptor on a
118 modified Borg category ratio-10 (CR-10) scale. Following the training session, coaches

were asked to provide another RPE measure to the lead researcher using the same method, this time relating to the intensity they thought the training session was. Coaches were instructed to provide intended and observed RPE's for individual players within the session rather than providing a global RPE for the entire squad. Athletes who took part in each of the training sessions were asked to provide an RPE measure in the same manner as the coaches with measurements taken in isolation from other participants to avoid external influence on selection. Measures of RPE were taken approximately 30 minutes following each training session to avoid any influence the activities completed towards the end of each training session had on RPE (12).

Sessions were grouped as easy (1-2), moderate (3-4) and hard (5-10) based on the intended session RPE of the coach with the corresponding athlete/coach observed RPE aligned to each response. A total of 28, 125 and 66 easy, moderate and hard training sessions were analysed respectively.

STATISTICAL ANALYSIS

A univariate analysis of variance with participants controlled for as a random factor was used to calculate within-participant correlations and associated 95% confidence intervals (95%CI) between coach intended RPE, coach observed RPE and athlete RPE for easy, moderate and hard training sessions (3). The univariate analysis of variance provided a partial ETA squared value which was subsequently square rooted to provide a value of r. The magnitude of the correlation was classified per the following thresholds; *r*= 0.1-0.29 *small*, 0.3-0.49 *moderate*, 0.5-0.69 *large*, 0.7-0.89 *very large*, 0.9-0.99 *nearly perfect*, 1 *perfect* (18). Statistical analyses were carried out using the SPSS statistical analysis software for mac (version 24.0, SPSS Inc., Chicago, IL, USA).

143 Differences between the mean values for coach intended, coach observed and
144 athlete RPE for easy, moderate and hard session intensities were assessed using a
145 customised excel spreadsheet (17). The threshold for a change to be considered
146 practically important (the smallest worthwhile change; SWC) was set at 0.2 x observed
147 participant standard deviation (SD), based on Cohen's *d* effect size (ES) principle. The
148 magnitude of difference was classified as <0.2 *trivial*, 0.21 to 0.6 *small*, 0.61 to 1.2
149 *moderate*, 1.21 to 2.0 *large* and >2.0 *very large* (18). Effect sizes are presented with
150 associated 90% confidence intervals (18). The probability that the magnitude of change
151 was greater than the aforementioned effect size thresholds was rated as follows; <0.5%
152 *almost certainly not*, 0.5-5% *very unlikely*, 5-25% *unlikely* 25-75% *possible*, 75-95%
153 *likely*, 95-99% *very likely* and 100% *almost certainly* (18).
154
155 **RESULTS**
156 Table 1 displays the mean and standard deviations (SD) of coach intended RPE, coach
157 observed RPE and athlete RPE for all training sessions grouped together as well as
158 sessions intended to be easy, moderate and hard.
159
160 *****INSERT TABLE 1 NEAR HERE*****
161
162 Table 2 displays the correlation coefficients and 95% confidence intervals for coach
163 intended RPE, coach observed RPE and athlete RPE for all training sessions grouped
164 together as well as sessions intended to be easy, moderate and hard.
165
166 *Coach Intended RPE vs. Athlete RPE*

Figure 1 displays the regression plots for the agreement between coach intended RPE and athlete RPE. There was a *moderate* correlation (r=0.39; 0.27 to 0.49) between coach intended RPE and athlete RPE when all sessions were considered together. Separating training sessions into those intended to be easy, moderate and hard provides further understanding of the relationship between coach intended RPE and athlete RPE. *Moderate* correlations were found between coach intended RPE and athlete RPE for sessions intended to be both moderate and hard, whilst a *small* correlation was found between athlete RPE and sessions the coach intended to be easy

There was *almost certainly* a *moderate* difference between coach intended RPE and athlete RPE for sessions intended to be easy (Effect Size = ES (ES; 1.17; 0.7 to 1.65) and *likely small* differences between athlete RPE and sessions the coach intended to be moderate (ES; -0.36; -0.56 to -0.11) and hard (ES; -0.46; -0.72 to -0.20) respectively.

*****INSERT FIGURE 1 NEAR HERE*****

Coach Observed RPE vs. Athlete RPE

Figure 2 displays the regression plots for the agreement between coach observed RPE and athlete RPE. There was a *large* correlation (r= 0.63; 0.54 to 0.70) between coach observed RPE and athlete RPE when all training sessions were considered together. When training sessions were separated into the coach intended intensities, there was a *large* correlation between coach observed RPE and athlete RPE for sessions intended to be easy, a *small* correlation for sessions intended to be moderate and a *very large* correlation for sessions intended to be hard.

There was a *likely moderate* difference between coach observed RPE and athlete RPE for sessions intended to be easy (ES 0.83; 0.4 to 1.28), a *likely small* difference (ES -0.29; -0.46 to -0.11) for sessions intended to be moderate and a *possibly trivial* difference for sessions intended to be hard (ES -0.05; -0.24 to 0.36).

*****INSERT FIGURE 2 NEAR HERE*****

*****INSERT TABLE 2 NEAR HERE*****

DISCUSSION

This study investigated the level of agreement between the intended RPE set by the coach and the post session RPE of the athlete as well as the agreement between the coach and athlete post session RPE at different session intensities (easy, moderate, hard). The study found a lack of agreement between the intended session RPE of the coach and the RPE of the athlete. *Small* and *moderate* within participant correlations were found following sessions intended to be easy, moderate and hard respectively. Despite the lack of synchronisation between intended training intensity and the intensity perceived by the athletes, the agreement between coach and athlete RPE improved following training with *large* and *very large* correlations found between coach observed and athlete RPE for sessions intended to be easy and hard respectively. A *moderate* correlation was found for sessions intended to be of a moderate intensity.

In line with previous research in both swimming (27) and running (11), intended coach RPE underestimated session intensity for easy sessions but overestimated

intensity for sessions perceived to be hard. Despite similar findings, the correlation coefficients between intended coach RPE and athlete RPE found in swimming (r=0.84) and running (r=0.75) were larger than the correlation coefficient found within the present study (r=0.39). The different sports analysed in the respective studies may explain the dissimilarity in findings. When prescribing a training load for an individual swimmer or runner, the coach can be more vigilant on the workload completed during the session (e.g. control of meters swam/ran, time taken) facilitating a higher level of agreement between intended intensity and athlete RPE. Alternatively, the team sports (rugby, hockey, netball and soccer) analysed within this study offer a more complex challenge to the coach as certain players will naturally acquire a higher training load due to factors such as playing position or drill selection (5). Therefore, the coach must plan training intensities on an individual basis rather than applying an intended RPE for the entire squad.

Although research within team sports is sparse, *small* correlations between coach intended RPE and athlete RPE have been found in elite youth soccer (r=0.24) (5). In agreement with the present study, individuals found premeditated easy sessions to be harder than the coach intended but found harder sessions to be easier than intended. A potential reason for the lack of agreement between coach intended RPE and athlete RPE is the elevated perception of training intensity experienced by the athletes on training days intended to be easier. Training at a higher than intended intensity can contribute to a greater than anticipated level of muscle soreness post training (26), indicative of exercise-induced micro-trauma and an ensuing rise in muscle damage (8). As a result, the residual fatigue experienced by the athlete may limit performance in subsequent training sessions with previous literature demonstrating exercise induced

muscle damage to restrict anaerobic performance (1), high-speed running performance (8) and distance covered at a lower intensity (7). Additionally, literature examining the relationship between external training load markers and perceptions of session intensity within team sports has found that increased high speed running distance (15) and total distance (14) covered to correlate with athlete RPE. Therefore, the residual fatigue accumulated by athletes in the present study by training harder than intended on easy training days may have limited their ability to train at the required intensity on training days intended to be hard.

A lack of harmony between the intended session intensity and athlete RPE can lead to errors in training periodisation (6). Training sessions that were intended to be hard, were on average, perceived to be less intense by the athlete. To maintain or improve physiological characteristics it is essential the prescribed training load provides a sufficient stimulus to promote adaption, otherwise the youth athlete is left at risk of deconditioning (4). An insufficient accumulation of load may leave the athlete physically incapable of handling the stress placed upon them in match play or in a block of more demanding training sessions, pre-disposing the athlete to injury (13).

Alternatively, as training sessions become less intense to promote recovery, athletes who are perceiving sessions to be harder than expected are at risk of non-functional overreaching or overuse injury through the accumulation of excess training load (10). Problems arising through the inadvertent accumulation of load may be exacerbated for school or club sport athletes who compete in various sports or for various teams within the same sport (25). A consistent underestimation of training load across multiple training sessions, on top of school and social stress may predispose the youth athlete to a level of stress they are unable to cope with leading to overuse injury

or non-functional overreaching (10). Therefore, it is important that coaches are aware of the external training variables which contribute to elevated perceptions of intensity in their sport. Although previous research (14,15) has distinguished the training load factors which lead to higher RPE's in elite team sports it remains an under researched area within youth team sports with further research required. Such findings would provide coaches with the information necessary to plan more informed training sessions, increasing the likelihood of achieving the desired internal response.

As well as successfully achieving an intended training response, another important element in effective periodisation is accurately observing the intensity post session. Regardless of the intended session RPE, if the coach can accurately distinguish how hard a session was, they can make amendments to future training sessions to ensure the required training load is met. In line with previous research in youth soccer (6), this study found coaches to alter their post session RPE from the intended session RPE to be more in tune with the athletes perception of training intensity. Despite improved synchronisation of coach and athlete RPE, discrepancies continued to exist between perceptions of intensity for sessions intended to be easy and moderate. Previous research in elite youth tennis (24) and soccer (6) found the coach to underestimate session RPE in comparison to the athletes however the magnitude of correlation was not established for different session intensities. This study offers a greater insight into the relationship between observed coach and athlete RPE by assessing the level of agreement for easy, moderate and hard training sessions.

Following training sessions that were initially intended to be hard, coaches altered their perception of training intensity to align with athlete RPE. However, *moderate* and *small* differences between coach observed RPE and athlete RPE persisted

for sessions intended to be easy and moderate respectively. When assessing session intensity, coaches will focus on the difficulty of the session and provide an RPE based on the training activity alone. However, RPE can be affected by external sources of stress such as school work or social problems (23) meaning that the athlete RPE's analysed in the present study may not be a direct representation of the training session, restricting the correlation between coach observed and athlete RPE. Accounting for an individual's non-training related stress is a complex challenge and coaches should look to quantify load by recording individual RPE responses post training rather than relying on their own observations.

Although the present study considered youth athletes from 4 different sports (rugby, hockey, football and netball), there was an insufficient number of training sessions to differentiate the magnitude of correlations for the individual sports. Therefore, no inferences can be made regarding the influence of the sport played between coach intended/observed RPE and athlete RPE. Future research should seek to establish the correlation between coach and athlete RPE for each sport separately to ascertain if the level of agreement is affected by sport.

PRACTICAL APPLICATIONS

A mismatch between the coaches intended training intensity and the post session RPE of the athlete can lead to errors in periodisation. An overestimation of RPE, as seen in this study for intended hard and moderate sessions, can leave the athlete at risk of deconditioning via an insufficient training stimulus to promote physiological adaption (4). Alternatively, an underestimation of load as seen during intended easy training sessions may predispose the athlete to overuse injury or non-functional overreaching

through an inability to handle the excess load (10). If intended training loads are not being achieved, the coach can still make necessary adjustments to training by increasing or decreasing session intensity in upcoming sessions so that training loads realign with the intended periodisation. The modification of training load would require the coach to be able to accurately observe the intensity of the training session before making subsequent changes. This study indicates that although the coach modifies their intended RPE following training, the observed RPE still *moderately* underestimates RPE for easy sessions with a *small* overestimation of athlete RPE for intended moderate sessions. It is recommended that coaches put in place training load monitoring strategies such as quantifying load through individual RPE responses following training, rather than relying on their own perception of session intensity. Such strategies would increase the accuracy of training periodisation reducing the problems arising from an over/under prescription of training load.

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Table 1; Coach intended RPE, athlete RPE, and coach observed RPE for Easy, Moderate and Hard training sessions (Mean ± SD).

Coach Intended RPE (AU)	Athlete RPE (AU)	Coach Observed RPE (AU)
All training sessions (3.6 ± 1.2)	3.5 ± 1.8	3.5 ± 1.1
Intended Easy sessions (1.9 ± 0.3)	3.8 ± 2.2	2.3 ± 0.9
Intended Moderate sessions (3.2 ± 0.4)	2.9 ± 1.2	3.1 ± 0.4
Intended Hard sessions (5.2 ± 0.6)	4.5 ± 2.1	4.6 ± 1.1

Data are presented as mean ± SD, RPE (Rating of Perceived Exertion), AU (Arbitrary Units).

Table 2; Relationships between coach intended RPE, athlete RPE and coach observed RPE for Easy, Moderate and Hard training sessions.

	Coach Intended RPE		
	Easy	Moderate	Hard
Athlete RPE	r= 0.39; 95% CI 0.02-0.67	r= 0.27; 95% CI 0.1-0.43	r= 0.46 95% CI 0.25-0.63
Coach Observed RPE	r= 0.54; 95% CI 0.09-0.76	r= 0.20; 95% CI 0.02-0.36	r= 0.79; 95% CI 0.68-0.87

RPE (Rating of Perceived Exertion), CI (Confidence Intervals).